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SUBSTRATE ASSEMBLING APPARATUS

20 **Abstract:**

PROBLEM TO BE SOLVED: To provide a substrate assembling apparatus for which bonds substrates to each other in a vacuum with high accuracy.

SOLUTION: This assembling apparatus includes a moving mechanism for horizontally moving a table between the inside and outside of a vacuum

chamber and has a means for drawing an adhesive to closed patterns on the other substrate held on the table positioned outside the vacuum chamber and a means for dropping liquid crystals into the closed patterns of the adhesive on the other substrate. The device has a means for holding the one substrate
5 by suction attraction force to a pressurizing plate and a means for holding the same by electrostatic attraction force. The device has a means for accepting the one substrate falling from the pressurizing plate in a position to the extent of being slightly apart from the pressurizing plate when the suction attraction force does not act on the substrate any more in the
10 process of progressing the pressure reduction in the vacuum chamber and a means for moving this accepting means to the pressurizing plate side. The device is provided with a means for holding the one substrate to the pressurizing plate by acting the electrostatic attraction force thereon when there is the one substrate in this accepting means.

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[Claim(s)]

[Claim 1] An apparatus for assembling a substrate comprising the substrate only for attaching a surface below a pressing plate located at an upper side of a vacuum chamber and another attaching substrate on a table

5 located at a lower side in the vacuum chamber and opposes both substrates, forming a gap between both substrates in vacuum made narrow by an adhesive that is applied to the substrates and attaches the substrates to each other, comprises a moving tool for moving a table horizontally between an inside and outside of the vacuum chamber, and further comprising a means

10 for patterning the adhesive in a closed pattern to one substrate held on the table located outside vacuum chamber, a means for dropping liquid crystals within the closed pattern of the adhesive on this one substrate and comprises a means for holding the one substrate at the pressing plate with suction absorption force, a receiving means for receiving at a position

15 spaced somewhat from the pressing plate, the substrate in which in a process for making the decompression in the vacuum chamber with the holding means by an electrostatic absorption force, suction absorption force is not operated so that it only drops from the pressing plate, and a means for moving the receiving means to the pressing plate side, thereby when one

substrate is at the receiving means, by operating the electrostatic absorbion force, the apparatus has a means for holding one substrate to the pressing plate.

[Title of the Invention]

SUBSTRATE ASSEMBLING APPARATUS

[Detailed Description of the Invention]

[Field of the Invention]

5 The invention relates apparatus for assembling a substrate, which attaches the substrates by holding and opposing attached substrates with each other within a vacuum chamber, respectively, thereby reducing a gap in vacuum.

[Description of the Prior Art]

10 In a fabrication of a liquid crystal pane, there are processes for sealing a liquid crystal at a space formed by attaching (hereinafter, referred to the substrate after attach as cell) two sheet glass substrate to which a transparent electrode or a thin film transistor array is attached, with an adhesive (hereinafter, also referred to as adhesive material) with a very narrow
15 gap of a few μm .

 In the sealing of the liquid crystal, there are method proposed in Japan Patent laid-open disclosure No. 1987-165622, wherein by dropping the liquid crystal on one substrate on which the adhesive material is patterned in a

closed pattern without any inlets being formed, and arranging one substrate on another substrate, an upper and lower substrates are attached close to each other in vacuum and Japan Patent laid-open disclosure No. 1998-165622, wherein by patterning a pattern of the adhesive material to form inlet
5 on one substrate, the adhesive material is injected from the inlet of the adhesive material after attaching the substrate in vacuum.

In above conventional art, both substrates are attached in vacuum, regardless of before and after patterning the pattern of the adhesive material. In vacuum, the substrate can not be sucked and absorbed with a pressure
10 difference with atmosphere pressure, as in standby state.

If an end of the substrate located in upper side (hereinafter, referred to as a upper substrate) is holded mechanically, a center portion of the substrate is bent, and the bend is being large as the substrat become more and more large and thin lately.

15 Since a position decision is practiced using a position alignment mark mounted to main ends of each of the upper and lower substrate, larger the bend of the substrate is, wider gap between ends of both the substrates get, thus the position can not be aligned.

Also, since a center portion of the upper substrate is contacted with

the substrate located in lower side (hereinafter, referred to as a lower substrate) before a main portion is contacted the lower substrat, a spacer that is distributed between the substrates to unify the substrate spacing is moved so that an alignment layer, etc. formed on the substrate is damaged.

5 Since the upper and lower substrate attached is same size each other, maintenance hardly take a cost.

Therefore, it is the object of the invention to provide an apparatus for assembling the substrate that can attach substrates of same size in high precision in vacuum, although a size of the substrate is being more and more
10 large and thin.

[Means for Solving the Problem]

To achieve the above object, the invention comprises a apparatus for assembling a substrate, the apparatus holds the substrate only for attach a surface below a pressing plate located at upper side in a vacuum chamber,
15 holds another attaching substrate on a table located at lower side in the vacuum chamber and opposes both substrates, makes a gap of both the substrates in vacuum narrow by adhesive that is applied to the substrates and attaches the substrates each other, comprises a moving tool for moving a table horizontally between inside and outside of the vacuum chamber, and

comprise a means for patterning the adhesive in a closed pattern to one substrate held on the table locating outside vacuum chamber, a means for dropping a liquid crystal within the closed pattern of the adhesive on this one substrate and comprises a means for holding the one substrate at the pressing plate with suction absorption power, a receiving means for receiving at a position spaced somewhat from the pressing plate the substrate in which in a process for making the decompression in the vacuum chamber with the holding means by a electrostatic absorbion power, suction absorption power is not operated so that it only drop from the pressing plate, and a means for moving the receiving means to the pressing plate side; thereby when one substrat is at the receiving means, by operating the electrostatic absorbion power, the apparatus has a means for holding one substrate to the pressing plate.

[Embodiment of the Invention]

Hereinafter, this invention is descirbed in reference to one embodiment.

In Fig. 1 to Fig. 3, the substrate assembling apparatus of the invention is constituted of a liquid crystal droplet S1 and a substrate attach part S2, and both is arranged adjacent to upper side of a holder 2. On the upper side

of the frame 2, there is a frame 3 supporting the substrat attach part S2. Also, on the surface of the holder 2, XY Θ stage T1 is equipped. X stage 4a is able to intercourse in left and right of x-axis directions in the figures, that is, between the liquid crystal droplet S1 and the substrate attach part S2, by driving motor

5 5. Y stage 4b is on the X stage 4a, and is able to intercourse in the direction of Y axis orthogonal to X stage by driving motor 6. Θ Stage 4c is on the Y stage 4b, rotatable horizontaly with Y stage 4b by driving motor 8 via a rotating bearing 7, and fixed with table 9 allowing the substrate to be mounted on the Θ stage 4c. Also, the Y stage 4b is fixed with the lower chamber 10 by the

10 plate 13. The Θ Stage 4c is mounted rotation-freely against axis A as the center of rotation by the rotation bearing 11 for the lower chamber 10 in between the vaccum chamber 12, so that it is constituted that the lower chamber 10 is not rotated, while the Θ Stage 4c is ratated.

The liquid crystal droplet S1 is constituted of a dispenser 17

15 supported by a bracket 14 projecting from the frame 3 for dropping a desired amount of liquid crystal material into the lower substrate 1 held in the table 9, Z-axis stage 15 for moving up and down it, and driving motor 16 for driving it. XY Θ stage T1, which holds and mounts the lower substrate 1a on the table 9, moves in the direction of X an Y in a nozzle 18 of the dispenser 17 for

20 dropping the liquid crystal material. As a result, a desired amount of the

liquid crystal material is dropped on any portions of the lower substrate 1a.

After dropping the liquid crystal, the XY Θ stage T1, which holds and mounts the lower substrate 1a, is moved by the driving motor 5 underlying the substrate attach part S3.

5 The substrate attach part S2 is constituted of the upper chamber 21 and an electrostatic absorption plate 28 therein, which are constituted to move up and down separately. In other words, the upper chamber 21 has a housing 30 comprising a linear bush and a vacuum chamber to allow the shaft 29 to move up and down in Z-axis direction, by a cylinder 22 fixed to the
10 frame 2 as a guide.

The XY Θ stage T1 is moved into the substrate attach part S2 to allow the flange of the upper chamber 21 to contact with O ring 44 arranged around the lower chamber 10 so that they are integrated, if the upper chamber 21 is dropped, thereby allowing it to function as the vacuum chamber.

15 The amount O ring 44 is broken adjusts the dropping stop position of the upper chamber 21 and holds the vacuum chamber into vacuum state, with the amount being set to obtain a maximum elasticity.

Even the vacuum chamber is constituted of the upper chamber 21 and the lower chamber 10 and is deformed, the housing 30 prevents vacuum

leakage for the shaft 29 and comprises a up and down movable vaccum chamber so that it can absorb power applied on the shaft by the deformation of the vaccum chamber, thereby nearly preventing the deformation of the pressing plate 27 fixed to the shaft 29 to hold the electrostatic absorption plate 28 and holding in parallel and attaching with the upper substrate 1b held in the electrostatic absorption plate 28 and the lower substrate 1a held in the table 9.

A vaccum valve 23 and a pipe hose 24 are connected to a vaccum source not shown to allow the pressure of the vaccum chamber to decompress so that the vaccum chamber becomes vaccum. Furthermore, a gar purge valve 25 and a gas tube are connected to a pressure source such as N₂ or a clean dry air, etc. to return the pressure of the vaccum chamber into atmosphere pressure.

Althouth the upper substrate 1b is held in very close with the lower surface of the electrostatic absorption plate 28, the upper substrate 1b is held in the electrostatic absorption plate 28 by suction absorption. That is, a connector for suction absorption 41 and a suction tube 42 are connecte to the vaccum source not shown and the electrostatic absorption plate 28 is arranged with a plurality of suction apertures connected thereto.

In case the surroundings are air, it is allowed to use together the electrostatic absorption and it is not necessary to perform the suction absorption in case the electrostatic absorption is large.

Furthermore, the electrostatic absorption plate 28 is arranged to the pressing plate 27 held by the shaft 29 and the shaft 29 is fixed to the housings 31, 32. The housing 31 is arranged as a linear guide 34 for the frame 2 to allow the electrostatic absorption plate 28 to drive up and down. The down drive is performed by the motor 40 fixed to the bracket 38 on the frame 35, which is connected to the frame 2. The transfer of the drive is performed by a ball screw 36 and a nut housing 37. The nut housing 37 is connected to the housing 32 via a load cell 33 to operate in integrated with the electrostatic absorption plate 28 underlying thereof.

As a result, the shaft 29 is fallen by the motor 40 and the upper substrate 1b is very close to the upper and the lower substrates 1a, 1b of the table 9 by falling the electrostatic absorption plate 28 holding the upper substrate 1b so that it can reduce the pressing power. In this case, the load cell 33 operates as a pressing power sensor and controls the motor based on the feedback signals in turn so that the pressing power can be applied to the upper and the lower substrates 1a, 1b.

Since the lower substrate 1b is mounted in direction of gravity, as shown in Fig.2 although the determination of position becomes sufficiently by pressing a position determination member 81 arranged in the table 9 in a horizontal direction by a pressure roller 82. When determining a fine position
5 immediately before attach, since the lower substrate 1b may be deviated or lift up by contacting the upper substrate 1b with a real material or a liquid crystal material on the lower substrate 1a or the air between the lower substrate 1a and the table 9 may be leaked in the course of making the vaccum chamber into vaccum by depressing the inside of the vaccum
10 chamber so that the lower substrate 1a may be deviated, the table 9 is allowed to have the electrostatic absorption function. Also, if the table 9 is mounted and grounded with a pin, which can move up and down in Z-axis direction, it can easily perform to prevent a cell from being charged with electricity after the substrate attach and remove the cell from the table 9.

15 A resin bathtub 60 shown in Fig. 2 is received slightly below the the electrostatic absorption plate 28, if the upper substrate 1b is fallen by allowing the electrostatic absorption plate 28 to perform the suction absorption for depressing the vaccum chamber to disappear the suction absorbtion power and is positioned in the two opposite angles of the upper
20 substrate 1b and is supported in the form of suspension to the shaft 59

extending into the lower. As shown in Fig. 3 more specifically, the shaft 59 becomes the vacuum chamber in between the housing of the upper chamber 21 so that it can be rotated and moved up and down. That is, the shaft 59 is a elevation actuator 62 fixed to the bracket mounted the shaft 29 and can more
5 move up and down independently of the up and down movement of the shaft 29 as well as rotate by a rotation actuator 61.

Subsequently, it will be described referring to the electrostatic absorption plate 28 for absorbing the substrate.

The electrostatic absorption plate 28 is an insulating plate and has two
10 convex parts in the form of square, with each convex part being cover a built-in flat electrode with dielectric to allow the circumference of the dielectric to become co-plane with the lower plane of the electrostatic absorption plate 28. Each flat electrode embedded is connected to +/- direct current power sources, respectively, via a suitable switch.

15 Accordingly, if +/- voltage is applied to the each flat electrode, the circumference of the dielectric which become co-plane with the lower plane of the electrostatic absorption plate 28 is resulted +/- charge, thereby performing the electrostatic absorption of the upper substrate 1b using cron power generated between the transparent electrodes of the upper substrate

1b. The polarity of voltage applied to the each flat electrode may be the same or otherwise.

Then, it will be described about the substrate attach process using the substrate assembling apparatus.

5 Firstly, the table 9 is mounted a zig holding the upper substrate 1 and the XY Θ stage T1 is moved into the substrate attach part S2 by the driving motor 5. The motor 40 falls the pressing plate 27 or the electrostatic absorption plate 28 in between the shaft 29 to perform the suction absorption of the upper substrate 1b of the table 9 and then to lift it by the motor 40 so
10 that the upper substrate 1b becomes standby state.

The XY Θ stage T1 return into the liquid crystal droplet S1 and an empty zig is separated to allow the lower substrate 1a to mount on the table 9 to fix and hold it at a desired position as shown in Fig. 2.

Although not shown in Fig.1, the frame 3 is mounted with a dispenser
15 for discharging a real material. When discharging the real material with moving the lower substrate 1a in XY-axis directions by the each motor 5, 6 of the XY Θ stage T1, it can pattern the real material in a closed pattern on the lower substrate 1a. Then, the liquid crystal material is dropped on the lower substrate 1a from the dispenser 18. In this case, the real material becomes a

dam to prevent the dropped liquid crystal material from being swept away.

Subsequently, the vacuum chamber is constituted of the lower chamber 10 by allowing the XY stage T1 to move into the substrate attach part S2, the upper chamber 21 to fall into the cylinder 22, and the flange part 5 21 to engage with the O ring 44. Also, the vacuum is depressed by opening the vacuum valve 23. At this time, since the upper substrate 1b becomes the suction absorption state by the electrostatic absorption plate 28, the vacuum chamber is going to become depressing and become vacuum and the suction absorption power disappear, so that the upper substrate 1b is fallen by its 10 self-weight. As shown in Fig. 2, it receives into the resin bathtub 60 and as shown in Fig. 3, is positioned at slightly below the electrostatic absorption plate 28.

At the time when the inside of the vacuum chamber becomes vacuum sufficiently, the voltage is applied to the electrostatic absorption plate 28 to 15 allow the upper substrate 1b of the resin bathtub 60 to absorb and hold into the electrostatic absorption plate 28 by the cron power. In this case, since the vacuum chamber becomes already vacuum, no air remains between the upper substrate 1b and the electrostatic absorption plate 28. Also, the upper substrate 1b is not deviated when discharging air. More importantly, the

upper substrate 1b is very close to the electrostatic absorption plate 28 without intervening air. For this reason, it prevents the discharge caused by an organic charge.

Generating the discharge as long as air remains, the air is expanded to
5 allow the upper substrate 1b to laminate from the electrostatic absorption plate 28 or the upper substrate 1b of thin plate of glass material to break. However, according to the present embodiment, since no air remains, such events are not caused.

Subsequently, the shaft 59 is fallen by the elevation actuator 62 and
10 the shaft 59 is then rotated by the rotation actuator 61 so that the resin bathtub 60 does not interfere the attach of the up and down substrates. The pressing plate 27 is fallen by the motor 40 to control the motor 40 with measuring the pressing power by the load cell 33 so that the up and down substrates 1a, 1b are attached in a desired gap.

15 In this case, since the upper substrate 1b is very close to the electrostatic absorption plate 28 to prevent the center portion from being sunk, it has not adversely effect on the spacer in the liquid crystal material or it is not impossible to align the position of the substrates themselves. Also, the position alignment is performed by reading the position alignment mark

arranged in the upper and the lower substrates 1a, 1b, respectively, from a gap aperture (not shown) formed in the upper chamber 21 by an image recognition camera and measuring the position by the image process, thereby allowing each of the stages 4a to 4c of the XY stage T1 to move
5 finely and perform the position alignment in a high precision.

If the attach is completed, the vacuum valve 23 is grasped to open the gas purge valve 25, so that the inside of the vacuum chamber is supplied with N₂ or a clean dry air to return the pressure of the vacuum chamber into atmosphere pressure. Then, the gas purge valve 25 is closed to lift the upper
10 chamber 21 by the cylinder 22, so that the XY stage T1 is returned into the liquid crystal droplet S1 and the cell is removed from the table for attaching later. At this time, since there is in case the cell after attaching is charged with electricity, it should be performed process removing the electricity in the cell by contacting it with the electricity removing bar grounded or exposing to an ion
15 wind, etc. and then removing the cell from the table 9. The cell removed from the table 9 is actually cured by a UV light irradiating apparatus or a heating apparatus, etc.

Since the present embodiment as described above drops the liquid crystal by discharging the real material and immediately, performs the attach,

no dust is on the substrate to enhance a manufacturing yield. Also, the XY Θ stage T1 is used to carry into the vacuum chamber of the upper chamber 1b to promote the compactness of the apparatus.

The invention is not limited in the embodiments as described above,
5 but can be practiced as follows.

(1) For supplying into the electrostatic absorption plate 28 of the upper substrate 1b, the XY Θ stage T1 is arranged with a plurality of the elastic resin bathtubs (corresponding to the resin bathtub in Fig. 2), when the XY Θ stage T1 is in the liquid droplet S1, the upper substrate 1b is mounted
10 on the plurality of the resin bathtubs and the XY Θ stage T1 moves into the substrate attach part S2.

(2) Also, it is possible to directly suction-absorb into the electrostatic absorption plate 28 from a robot arm.

(3) It is possible to receive the upper substrate 1b falling when
15 preceding the depression by the resin bathtub, which is mounted in the XY Θ stage T1 described above in (1).

(4) It is possible to press the upper substrate 1b into the electrostatic absorption plate 28 before the upper substrate 1b is fallen by the resin bathtub 60 in Fig. 2 or the resin bathtub mounted in the XY Θ stage T1

described above in (1), procede the decompression from the suction
absorption state into the electrostatic absorption plate 28, and transform into
the electrostatic absorption. In this case, the upper substrate 1b is not very
close to the electrostatic absorption plate 28 physically to make air between
5 the upper substrate 1b and the electrostatic absorption plate 28 into vacuum
state, along with the decompression.

(5) Also, it is possible to hold a position spaced slightly the upper
substrate 1b from the electrostatic absorption plate 28 by the resin bathtub
60 in Fig. 2 or the resin bathtub mounted in the XY stage T1 described
10 above in (1) and perform the suction absorption in the course of preceding
the decompression without performing the suction absorption.

(6) Furthermore, it is possible to hold two angle parts (two corners
constituting the opposite angles) of the upper substrate 1b by the the resin
bathtub 60 in Fig. 2, but it is possible to hold four angle parts of the upper
15 substrate 1b or two sides of a long direction or two sides of width direction in
the four sides of the upper substrate 1b, by a suitable means.

[Effect of the Invention]

According to the invention as describe above, even the size of the
substrate is large and the substrate is a thin plate, it can attach the almost

same substrates in high precision under vacuum.

[Description of Drawings]

Fig. 1 is a schematic diagram of a substrate assembling apparatus showing one embodiment of the invention.

Fig. 2 is a perspective diagram showing situations when attaching
5 **each of the substrates.**

Fig. 3 is a cross section diagram of main portions showing situations immediately before attaching the up and down substrates by applying the electrostatic absorption power to the upper substrate.